Natural OUTLOOK

PD-020/13-04 APRIL 2013

"Testing air is much like how the speed and direction of wind is determined by measuring its effects on a wind vane and anemometer—chemicals can be measured by their interaction with electrical fields, ultraviolet light, infrared light, and x-rays." —TCEQ Air Lab and Quality Assurance Section Manager Cindy Maresh

MAKING THE UNSEEN VISIBLE

Analyzing ambient air at the TCEQ Air Lab

Chemists Jiann-Ping Loh (front) and Jaydeep Patel analyze air samples. Photo upper left: An air-sample canister.

Air, a precious mixture of invisible and odorless gases—nitrogen, oxygen, argon, carbon dioxide, and water vapor—that is essential for life, is under inspection on the second floor of a north Austin building, where scientists analyze it, down to the molecule, to ensure quality air in Texas.

Sandwiched between office corridors, in a building that sits along the constant stream of traffic of IH 35, the TCEQ air laboratory resembles the labs found in any scientific facility, complete with the white lab coats each staff member wears. With five sections, in separate testing areas, the air laboratory analyzes air samples and generates data reports to federal and state monitoring network experts, regional investigators, and other TCEQ program areas.

The 12 chemists at the air lab have their work cut out for them. Texas has the most extensive, aggressive air-watch program in the country. With the regular sampling at the 121 monitoring sites across the state, and the many special regional investigations being conducted, close to 7,500 ambient air samples are analyzed at the lab every year—using the latest scientific research and cutting-edge technology.

"Six different types of samples are received in the laboratory and each sample type undergoes a specific test—organic compounds, non-methane organic compounds, carbonyls, polycyclic aromatic hydrocarbons, particulates, and microscopic analyses," said Air Lab Manager Ken Lancaster. "From those six tests, results are drawn on 170 different compounds, including naphthalene, acetone, air toxics such as benzene and 1,3-butadiene, ozone precursors such as propylene, and even insect parts."

"Testing air is much like how the speed and direction of wind is determined by measuring its effects on a wind vane and anemometer—chemicals can be measured by their interaction with electrical fields, ultraviolet light, infrared light, and x-rays," says TCEQ Air Lab and Quality Assurance Section Manager Cindy Maresh.

Particles and chemicals are invisible to the naked eye because they are either too small or colorless. If a particle is too small to be seen, the lab can either calculate the air concentration of breathable particles by collecting them on filters or use light and electron microscopes to magnify particles. A light microscope can magnify a particle up to 400 times its size, and an electron microscope up to 10,000 times. If certain metals, such as arsenic or chromium, are of concern, the air laboratory sends the sample to the Houston lab for additional testing. For certain chemicals, the lab uses a flame ionization detector, a mass spectrometer, or an ultra-performance liquid chromatograph.

"The lab uses detectors which can measure the variations due to these interactions," says Lancaster. "Each instrument is designed to detect a specific type of chemical. The chemical identities and concentrations can be obtained by comparing instrument variations on ambient samples to instrument variations on standards containing known chemicals at specific concentrations."

Increased Activity

In addition to the air canisters routinely collected from the statewide ambient monitoring stations, the TCEQ air lab also analyzes canisters collected by regional personnel as part of investigations.

Prior to 2009, the lab analyzed approximately 200 canisters annually. In four short years, with the intensification in oil and gas production in the state—namely in the Barnett Shale (in the Dallas–Fort Worth area) and the Eagle Ford Shale (in South Texas)—the lab testing has increased dramatically, to between 500 and 600 canisters annually. In that four-year span, the lab analyzed over 1,300 canisters from the Barnett Shale area alone.

The typical cycle of the 14-inch rounded metal canisters begins in the field, where investigators use them to collect ambient air. The canisters are then shipped back to the TCEQ air lab, where they are stacked neatly in rows of shelves in the VOC (volatile organic compound) section of the facility. Then, their invisible contents are subjected to a rigorous testing protocol, analyzed for 85 volatile organic compounds. Nearby stands a massive container of liquid nitrogen, which is used to trap the VOCs in the analysis process. The jagged lines on the computer screens detail the results. The entire process in the laboratory takes a minimum of two days to complete.

Once the air in them has been tested, the canisters are thoroughly cleaned—and reused. Approximately 1,500 canisters, which cost $450 each, are rotated daily.

Steve Meyer shows a carbonyl cartridge.

TCEQ photos by Douglas Falls

The PAH (polynuclear aromatic hydrocarbons) lab.

Systematic Study

Carbonyls

Formed by fuel combustion, mobile sources, and emissions from oil refineries, carbonyls (namely formaldehyde and other compounds) play a significant role in the creation of ozone.

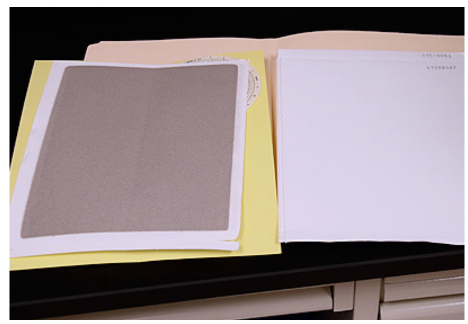
In one section of the air lab, scientist Steve Meyer employs liquid chromatography—which uses temperature and liquids under pressure to separate the sample for analysis—to test for 17 air toxics in a single plastic cartridge. These absorbent sampling cartridges are deployed at six monitoring sites across the state (one site each in Dallas, Fort Worth, Tyler, and El Paso, and two in the Houston area). The agency conducted approximately 1,200 carbonyl tests each year. The carbonyl cartridges are used once, and then discarded.

Particulates

While air is imperceptible to the naked eye, there are always minute particles, or particulates, suspended in air. Whether they originate from hair spray, seasonal pollen, lawn mowing, dust and dirt, or industrial sources, these particulates can affect health if present in high enough concentrations.

But when it comes to analyzing particulates, for all the technology and resources at their disposal, TCEQ personnel use a simple piece of snow white paper to capture what floats in the air.

The paper is made from fiberglass or quartz. At the air lab, it's weighed in a clean room, which uses a special filtration, humidification, and air conditioning system to eliminate any indoor particulates and maintain a constant humidity and temperature. The paper is then sent to the agency's regional offices, to be installed at 34 monitoring stations across the state. Over a 24-hour period the paper captures any particulates in the air. It then comes back to the air lab in Austin, where it is re-weighed.



Examples of particulate testing paper before (on the right) and after sampling.

This scale weighs paper before and after collecting particulates.

Polynuclear aromatic hydrocarbons

Polynuclear aromatic hydrocarbons (PAHs) form with the combustion of hydrocarbons, such as coal and gasoline, but can also be produced in the burning of garbage or in forest fires. Found primarily in soil, they can also be found suspended in air, as particulate matter.

The TCEQ monitors PAH concentrations in the air at sites at five locations (in four TCEQ regions): Karnack (Tyler region), Socorro (El Paso region), Deer Park (Houston region), and Brownsville and Mission (Harlingen region). Samples are collected every six days and analyzed in the Austin lab for 16 different compounds using a mass spectrometer, which separates chemicals based on their volatility.

To capture a PAH sample, the agency uses a small plastic cylinder containing two foam plugs, with resin in between.

"We call it a puff sandwich," said Lancaster.

A PAH sampling cylinder, or "puff sandwich."

TCEQ photos by Douglas Falls

James Mayer analyzes elusive samples for identification.

Microscopy

Sometimes even TCEQ investigators are at a loss to determine the source of a deposited substance on a complainant's property. When identification of a substance eludes them, they look to James Mayer, in the agency's microscopy lab.

"This area is known as the CSI of the air lab," he said. "When objects are not readily identifiable to the investigator, they come to me."

Using regular light microscopes and a high-powered scanning electron microscope, plus Mayer's extensive training and knowledge in identifying particles, the mystery is usually solved. Mayer is able to identify a variety of substances including pollen, paint chips, common clays and minerals, and insect parts. In fact, approximately one in 20 samples he receives ends up containing an insect body part.

But sometimes even the scientist is perplexed. "I once had a sample that I just couldn't identify," he admitted. "It was from an investigation at a house. The investigator sent me what appeared to be pellets the size of BBs, located on a roof. It was possibly satellite debris, or space junk." It remains a mystery.

Advances in Air Sampling and Testing

Air-sampling technology has come a long way in the last ten years—and this includes everything from the devices used to collect the samples, to the instruments used to analyze the samples.

"Every improvement to the overall process—from sampling to reporting—provides more reliable and consistent measurements of the compounds in the air, as well as providing time-saving efficiencies in the laboratory," said Cindy Maresh. "These advances have increased the agency's ability to further safeguard the air we all breathe."

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